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EVALUATION OF POSEIDON UNISUIT AND O'NEILL SUPERSUIT SYSTEMS.(U)
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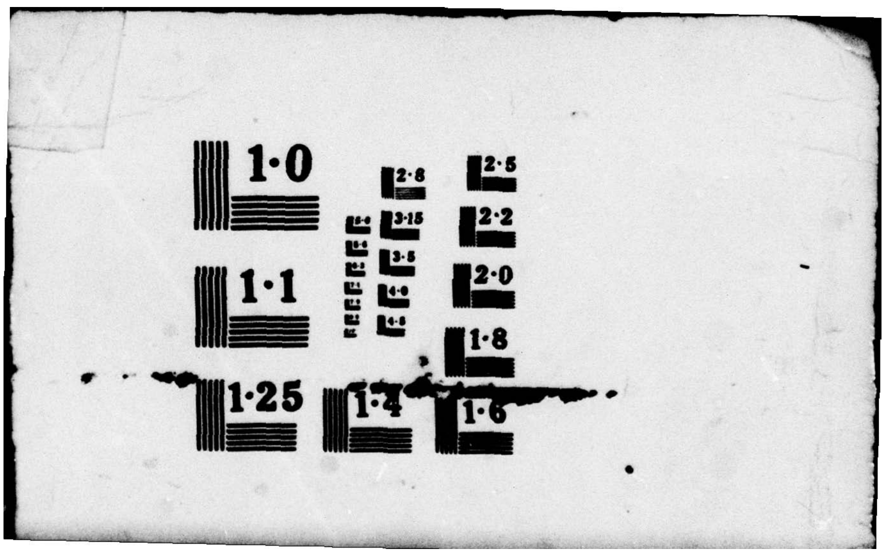
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DEPARTMENT OF THE NAVY
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NAVY EXPERIMENTAL DIVING UNIT
REPORT NO. 4-79

EVALUATION OF POSEIDON UNISUIT AND O'NEILL SUPERSUIT SYSTEMS

James R. Middleton

January 1979

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The Navy Experimental Diving Unit evaluated the Poseidon Unisuit and the O'Neill Supersuit systems for use with scuba, the MK 15 Mod 0 UBA, and the Diver's Mask MK 1 Mod 0, all in the variable volume mode. As a result of this manned testing, the O'Neill Supersuit has been recommended for inclusion on the list of equipment Approved for Navy Use (ANU). The Poseidon Unisuit is already included on that list. In addition, both suits are recommended for use as variable volume dry suits via low pressure inflators → over

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powered from the diver's first stage regulator or an independent pony bottle air source. It is further recommended that all diving commands implement comprehensive on-the-job-training programs to ensure that divers are thoroughly familiar with suit characteristics and buoyancy control/blowup prevention techniques.

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GLOSSARY

ANU	Approved for Navy Use
FSW	feet of seawater
IDV	integrated divers vest
L.P.	low pressure
NEDU	Navy Experimental Diving Unit
NSSC	Naval Sea Systems Command
OSF	Ocean Simulation Facility
psig	pounds per square inch gauge
scuba	self contained underwater breathing apparatus
UBA	underwater breathing apparatus
UDT	Underwater Demolition Team
variable volume dry suit	a dry suit supplied with low pressure air for inflation and buoyancy control via an L.P. inflator/deflator mechanism

ABSTRACT

The Navy Experimental Diving Unit evaluated the Poseidon Unisuit and the O'Neill Supersuit systems for use with scuba, the MK 15 Mod 0 UBA, and the Diver's Mask MK 1 Mod 0, all in the variable volume mode. As a result of this manned testing, the O'Neill Supersuit has been recommended for inclusion on the list of equipment Approved for Navy Use (ANU). The Poseidon Unisuit is already included on that list. In addition, both suits are recommended for use as variable volume dry suits via low pressure inflators powered from the diver's first stage regulator or an independent pony bottle air source. It is further recommended that all diving commands implement comprehensive on-the-job-training programs to ensure that divers are thoroughly familiar with suit characteristics and buoyancy control/blowup prevention techniques.

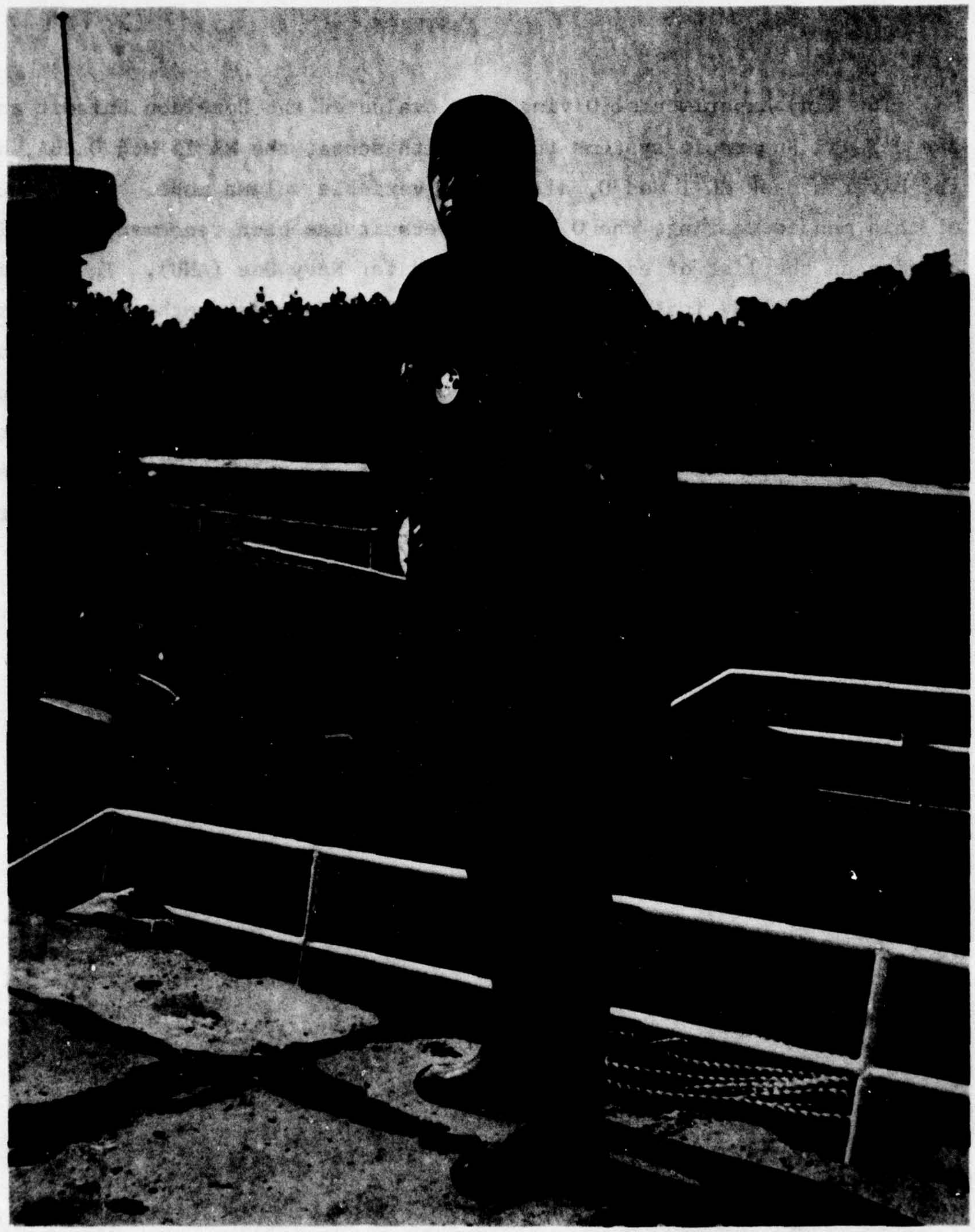

Figure 1. Poseidon Unisuit

INTRODUCTION

BACKGROUND

By direction of the Commander, Naval Sea Systems Command (reference 1), NEDU evaluated two commercially available dry suits for use in the variable volume mode via an L.P. inflation source. The Poseidon Systems Unisuit already has ANU status for use without an L.P. inflator. The O'Neill Supersuit was not authorized for Navy Use at the start of the test and was considered for ANU approval both in the constant volume and the variable volume (L.P. supplied) modes.

There are currently 8 to 10 variable volume dry suits available on the commercial market. The Unisuit and the Supersuit were chosen based on an extensive test series (references 2 and 3) conducted by the Naval Coastal Systems Center in Panama City, Florida. Construction, quality control, fit, mobility and thermal properties were evaluated. The Supersuit and Unisuit both ranked very high in all areas. The two suits also represent different approaches to suit configuration (loose vs. snug fitting), both of which have application in the Navy diving community and were consequently chosen for evaluation.

EQUIPMENT DESCRIPTION

1. Poseidon Unisuit

The Poseidon Unisuit (figure 1), manufactured by Poseidon System USA (a division of Parkway Fabricators), 291 New Brunswick Ave., Perth Amboy, N. J., 08861, is a one-piece suit constructed of 1/4-inch neoprene foam sandwiched between two nylon coats. A 52-inch waterproof zipper runs from the base of the neck, under the crotch, and up to the waist. Boots and hood are attached; dry gloves are separate. A 3/16-inch nylon outside/smooth skin inside neoprene cuff at the wrist, and a thin neoprene collar pulled down around the neck, seal the suit upon contact with the diver's skin. For durability and toughness, the boot soles are dipped in raw neoprene. Push-button buoyancy controls near the diver's chest comprise an inlet valve on the right side and an exhaust valve on the left side. The Unisuit is a loose fitting dry suit which allows the addition of diver thermal protection undergarments.

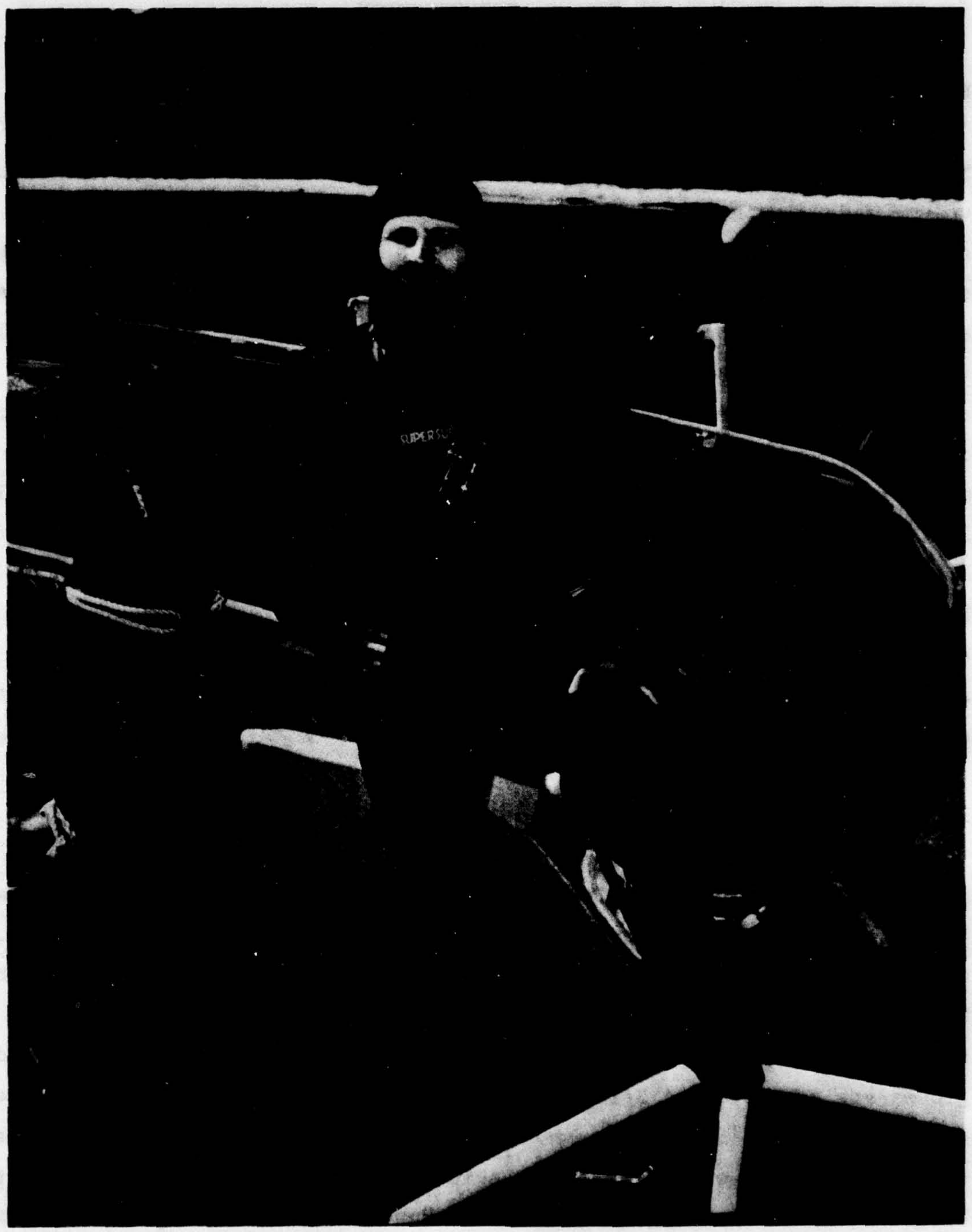

Figure 2. O'Neill Supersuit

2. <u>O'Neill Supersuit</u>

The one-piece O'Neill Supersuit (figure 2), manufactured by O'Neill Inc., Supersuit Division, 1071 41st Ave., Santa Cruz, California, 95062, like the Unisuit, is constructed of neoprene and nylon. The seams are cemented and strapped by a 1/16-inch layer of nylon tape; at the neck and wrist, neoprene seals fold under against the diver's skin. A 33-inch zipper extends across the back of the shoulders. Soft-soled boots are attached; hood, gloves and overshoes are separate. Dual-button valve buoyancy controls connect to the end of a 6-inch long hose attached to the left shoulder. One button activates the air supply; the other activates the exhaust. The Supersuit is a form fitting dry suit which approaches a conventional wet suit with respect to its snug fit properties. While additional undergarments are not as easily adopted as with the Unisuit, it is designed primarily as a suit for swimmers where a snug fit is imperative.

TEST PROCEDURE

TEST OBJECTIVE

A series of eight manned tests were conducted in the OSF Test Pool and Gulf of Mexico. The purpose of these tests was to evaluate (1) the Supersuit for placement on the list of equipment Approved for Navy Use (ANU), and (2) the Supersuit and Unisuit when used as variable volume dry suits with low pressure air supplied via an inflation/deflation mechanism.

TEST PROGRAM

1. Evaluation of Surface Floating Attitudes

In order to determine whether or not a diver's life preserver is required when using a variable volume dry suit with scuba and the MK 15 MOD 0 UBA, a series of buoyant ascents with the suits partially and fully inflated were conducted in the OSF Test Pool. Various attitudes of the diver on the bottom (15 FSW) were assumed prior to ascent to determine if the suits would float unconscious divers face-up on the surface regardless of initial ascent position or level of suit inflation. With one suit partially and the other fully inflated, the two divers assumed the following positions on the bottom prior to ascent:

a. Prone - face down
b. Prone - face up
c. Prone - right side down
d. Prone - left side down
e. Crouching - face down
f. Crouching - face up
g. Crouching - right side down
h. Crouching - left side down
i. Vertical - right side up
j. Vertical - upside down

During the partially inflated tests, each diver assumed each of the above positions on the bottom and inflated his suit via the L.P. inflator until he attained a slightly positive buoyant state. At that time he went limp and floated to the surface retaining his weight belt.

A surface observer then recorded his surface floating attitude (i.e., did diver surface face up with his head sufficiently out of the water to allow normal breathing).

The same procedure was followed with each suit during the fully inflated ascent tests except that an additional 20 pounds of lead was added to the divers' weight belts. When the diver had inflated his suit on the bottom to the point of becoming slightly buoyant, the entire weight belt was ditched, thus simulating a rapid, uncontrolled buoyant ascent.

2. Diver's Life Preserver/Dry Suit Interfacing Tests

a. The purpose of these series of tests was to determine each suit's compatibility with currently approved diver's life preservers. Using both scuba and MK 15 Mod 0 UBA, the following parameters were measured in the OSF Test Pool:

(1) Compatibility of life preserver with suit L.P. inflator and exhaust valve

(2) Suit inlet and exhaust valve operation with gloved hands when using various life preservers

(3) Suit and diver's life preserver interfacing problems.

b. The following diver's life preservers were evaluated in conjunction with both suits:

(1) Modified UDT Life Preserver (RFI)

(2) MK 4 Diver's Life Preserver (production prototype)

(3) Fenzy MK IV

NOTE

The MK 3 life preserver was not evaluated since it will be phased out shortly by the new MK 4.

3. Suit Interface with Scuba Harness, MK 15 Mod 0 UBA Harness and MK 1 Mod 0 Mask/IDV (No life preservers used)

Dressing procedures and suit valve compatibility for each configuration of suit/UBA were observed during pool and open water dives to evaluate the interfacing of each suit with the various UBA harnesses.

4. Air Consumption Evaluation

Air consumption tests were conducted in the Gulf of Mexico in 60 and 100 FSW using the predetermined dive scenarios listed below. The purpose of these tests was to determine how much air is normally used for suit inflation during multidepth dives of 60 and 100 FSW. The amount of air used for inflation is critical in determining whether or not the L.P. suit inflator should be powered from an independent source or from the diver's primary air supply.

The suit air supply for this test series was a small (15.5 cubic feet @ 3000 psig) pony bottle attached to the diver's scuba tanks. Air consumption was determined by gauging the pony bottle before and after each dive scenario.

Air Consumption Dive Scenario

Step 1 Divers formed two-man teams with each suit being used.

Step 2 Divers descended to the bottom with a compass board and attained neutral buoyancy using suit inflator.

Step 3 Divers swam on a predetermined compass course for twenty minutes on the 60 FSW dives and ten minutes on the 100 FSW dives. Minor adjustments to buoyancy were made by each diver during compass swims.

Step 4 Divers ascended to a depth equal to 1/2 of the bottom depth, attained neutral buoyancy and swam another predetermined compass course for twenty minutes on 60 FSW dives and ten minutes on 100 FSW dives.

Step 5 Divers descended back to the maximum depth attained in Step 3, gained neutral buoyancy and swam for the remainder of the no-decompression limit and surfaced.

Step 6 Upon surfacing, a positively buoyant state was achieved using L.P. inflators while waiting to reboard the dive boat.

5. <u>Evaluation of Suit Inflation Air Supply Source</u>

This test was conducted to evaluate the logistic problems encountered with various methods of supplying L.P. air to the suit inflators. The following configurations were tested:

a. Suit inflation pony bottle located on the diver's waist with scuba, Diver's Mask MK 1 Mod 0 and MK 15 Mod 0 UBA

b. Suit inflation pony bottle attached to scuba tanks, MK 1 Mod 0 Mask, or MK 15 Mod 0 UBA backpack

c. Direct inflation from the scuba diver's first stage regulator mounted on scuba tank, or direct from the MK 1 Mod 0 "come home" bottle first stage regulator.

NOTE

MK 15 Mod 0 UBA/Suit and MK 1 Mod 0 Mask/Suit combinations were tested in the OSF Test Pool. Scuba/suit combinations were evaluated in the Gulf of Mexico.

6. <u>Suit Failure Mode Evaluation</u>

These tests were conducted in the OSF Test Pool to determine the possible effects on diver safety of various suit failure modes. Suit failure modes evaluated were:

a. Loss of swim fins due to air collecting in the diver's feet when in the inverted position

b. Emergency ascent problems with a completely flooded suit

c. Suit exhaust valves' ability to adequately vent maximum inlet valve flow in case of the inlet valve failing in the open position

d. A diver's ability to achieve and cope with accidental uncontrolled suit blowup.

7. <u>Evaluation of Swimming Characteristics</u>

The purpose of these tests was to evaluate swimming characteristics of both suits. Divers' comments were recorded after each dive of Test 4. Divers were instructed to evaluate each suit for overall comfort, watertight

integrity, mobility, inflator/deflator ease of operation, ease of attaining neutral buoyancy and horizontal swimming characteristics.

8. Suit Accessories Evaluation

Suit accessories were used in various combinations during Tests 1 through 7. Divers' comments concerning comfort, dexterity, watertight integrity and ease of donning and doffing were recorded after each dive.

The following accessories were evaluated with each suit:

a. Watertight hood*

b. Gloves

c. Fin keeper straps

*The Unisuit hood is permanently attached to the suit. The Supersuit hood is optional and forms a watertight seal around the diver's neck and face when used with the Supersuit.

RESULTS AND DISCUSSION

1. Evaluation of Surface Floating Attitudes (Test 1)

Surface floating attitudes for the Unisuit and Supersuit are recorded in Table 1. The results of this test series indicate that both the Supersuit (with or without hood) and Unisuit (hood permanently attached) will float an unconscious open circuit scuba or MK 15 Mod 0 diver with his face sufficiently out of the water, as long as his weight belt has been ditched. If the weight belt is retained, it is possible that the diver's face may not be sufficiently out of the water so that he can breathe. It should be noted that this possibility exists only when a minimum level of positive buoyancy is maintained with the suit. When the suit is fully inflated, the divers floated face out of the water with or without a weight belt, thus indicating that these variable volume dry suits are adequate substitutes for conventional diver's life preservers.

2. Diver's Life Preserver Requirements (Test 2)

a. Modified UDT Life Preserver: No significant problems were noted with the interface of the Modified UDT life preserver and Unisuit. Operation of the inlet and exhaust valves with non-gloved or gloved hands was satisfactory. However, the Modified UDT, when fully inflated, was marginal in keeping the Unisuit diver with twin 72's on the surface with the suit fully deflated. An inflated Unisuit was not uncomfortable with this vest.

b. MK 4 Diver's Life Preserver: The inflated MK 4 was restrictive and uncomfortable on large divers wearing a non-inflated Unisuit. Operation of the inflation and deflation buttons was somewhat difficult on a small diver with or without gloves. On a larger diver, operation of the valves was almost impossible, especially with gloves. It was possible to inflate the Unisuit to a positive state and actually travel upward about 10 FSW before the exhaust valve could be actuated for deflation.

The MK 4 waist straps on large divers came up under the Unisuit inlet and exhaust valves, creating discomfort especially when the vest was inflated. The same problem affects accessibility to the inlet/exhaust control valves.

No problems were encountered when using the Supersuit with the MK 4 Life Preserver.

Table 1. Surface Flotation Attitudes

Position of Diver Prior to Ascent	Parameter	Poseidon Unisuit Diver Surface Position		O'Neill Supersuit Diver Surface Position	
		Diver #1	Diver #2	Diver #1	Diver #2
Prone/Face-down	1	Face-out	Face-out	Face-out	Face-in
	2	Face-out	Face-out	Face-out	Face-out
Prone/Face-up	1	Face-in	Face-out	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Prone/Right-side down	1	Face-in	Face-in	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Prone/Left-side-down	1	Face-in	Face-out	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Crouching/Face-down	1	Face-out	Face-out	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Crouching/Face-up	1	Face-out	Face-out	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Crouching/Right-side-down	1	Face-in	Face-in	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Crouching/Left-side down	1	Face-in	Face-in	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Vertical/Right-side-up	1	Face-out	Face-out	Face-out	Face-out
	2	Face-out	Face-out	Face-out	Face-out
Vertical/Upside-down	1	Face-in	Face-in	Face-in	Face-in
	2	Face-out	Face-out	Face-out	Face-out

PARAMETERS:

1 - Minimal positive buoyancy on bottom; diver retains his weight belt

2 - Full suit inflation with 20 lbs. over normal weight released prior to leaving the bottom

c. Fenzy VI Vest: The Fenzy posed several serious problems with the Unisuit. While the vest harness did not interfere with the operation of vest or suit, the on/off valve of the L.P. bottle mounted on the underside of the vest made operation of the inlet valve very difficult and actually disconnected the suit inflator as the diver swam through the water. Connecting the suit inflator hose was also very difficult due to L.P. bottle valve and inlet valve interference. Operation of the inlet valve with gloved hands was nearly impossible because the proximity of the bottle and inlet valves made identification of the suit inlet valve very difficult. No problems were encountered with the Supersuit.

Results of Test 1 show the Unisuit and Supersuit to be adequate flotation devices. However, in situations where a diver's life preserver is deemed necessary, it is advisable to use <u>only</u> the Modified UDT preserver to avoid operational problems if the Unisuit is worn. Any of the life preservers tested may be used safely with the Supersuit.

3. <u>Suit Interfacing with Scuba, MK 15 Mod 0 UBA and MK 1 Mod 0 Mask/IDV (Test 3)</u>

a. Scuba: No problems with a single tank, backpack-type harness were observed; the standard Navy double harness with chest straps caused slight interference with the inlet/exhaust valves on both suits. However, this problem is not serious and can be negated by adjusting the shoulder harness.

b. MK 15 Mod 0 UBA: No problems with suit/harness interfacing were observed. The single point MK 15 Mod 0 harness is easily adjusted to permit access to the inflator/deflator mechanisms on both suits.

c. MK 1 Mod 0 Mask/IDV: When used in conjunction with the IDV, the MK 1 Mod 0 Mask is totally unsatisfactory for a variable volume dry suit with L.P. inflation. The vest completely obstructed operation of the chest-mounted inlet/exhaust valves on both suits. However, when used with a come home bottle and standard single tank backpack, the MK 1 Mod 0 Mask presents no interface problems and provides comfortable dry suit protection for surface-supported diving operations.

4. <u>Air Consumption Evaluation (Test 4)</u>

A total of six man-dives were made in each suit (three dives in 60 FSW and three dives in 100 FSW). Results (Table 2) showed the Supersuit to use

Table 2. Suit Inflation Air Supply Consumption

Dry Suit	Dive No.	Charge Pressure (PSIG)	Post Dive Pressure (PSIG)	Consumption (PSIG)	Consumption (CU. FT.)	Average Consumption (PSIG)	Average Consumption (CU. FT.)	Average % of Consumption From Full 71.2 Cu. Ft. Scuba Tank
Supersuit	1	2500	1975	525	2.62			
	2	2800	2270	530	2.65			
	3	2800	2350	450	2.25			
	4	2700	2350	350	1.75	367.5	1.83	2.5%
	5	2800	2700	100	0.50			
	6	2900	2650	250	1.25			
Unisuit	1	2700	1600	1100	5.50			
	2	1975	1200	775	3.87			
	3	2700	1950	750	3.75			
	4	2650	2200	450	2.25	629.2	3.14	4.4%
	5	2900	2580	320	1.60			
	6	2880	2500	380	1.90			

NOTE: Dives 1-3 represent the 60 FSW scenario and Dives 4-6 represent the 100 FSW scenario.

considerably less air for pressure equalization and buoyancy control than the Unisuit. However, both suits required less than 5% of the divers' breathing gas supply when using single scuba tanks during multilevel dives at depths up to 100 FSW. It is important to note that both suits required less air from the L.P. inflator as the test divers became accustomed to using the suits.

An air consumption of less than 5% of a single 71.2 cubic foot scuba tank (2.5% for twin tanks) for suit inflation poses no threat to diver safety while still providing the advantages of thermal protection.

5. <u>Suit Inflation Air Supply Source (Test 5)</u>

a. Scuba and MK 1 Mod 0 Mask: Of the three methods tested, supplying the variable volume drysuits L.P. inflator via the diver's first stage regulator (scuba and MK 1 Mod 0 Mask with first stage regulator mounted on come home bottle) proved to present far less doffing/donning complications, greater in-water comfort, and less logistic support than the other methods. This method was convenient, simple, required only one extra L.P. hose attached to the diver's first stage and was proven safe in Test 4. Mounting a pony bottle on the diver's waist or to his scuba tanks are viable alternatives which are safe and effective. However, the first stage supply source is seen as the most logical solution to the air supply source problem.

b. MK 15 Mod 0 UBA: Since a MK 15 Mod 0 UBA diver must be supplied from an independent supply source, it warrants the use of a pony bottle. The backpack mount was deemed the most comfortable. However, mounting the 15.5 cubic foot bottle on the left or right side of the MK 15 backpack caused an imbalance on the diver when swimming horizontally. Mounting the pony bottle on any other part of the UBA produced clearance problems for a diver using the MK 15 in its operational profile. The 15.5 cubic foot bottle used in these tests measured 5 inches in diameter by 14 inches long and weighed over 10 pounds. The results of Test 4 show that a much smaller bottle (8 to 10 cubic foot capacity) would suffice for most diving operations. The smaller, lighter bottle should prove acceptable when mounted on the backpack of a MK 15 diver.

6. Suit Failure Modes Evaluation (Test 6)

Results of the four failure modes evaluated indicate that neither the Supersuit nor the Unisuit present any serious operational problems to a competent, well-trained diver. Results of each failure mode test are:

a. Loss of Swim Fins: Divers were positioned on the bottom of the OSF Test Pool and instructed to assume an inverted vertical position and fully inflate their suits. Both suits can lose fins in the extreme situation by being blown off by the diver's expanding foot pocket. However, in any other than the extreme case, loss of swim fins when the diver is in the vertical position is not a problem with either suit. In addition, this problem can be completely avoided by using the fin keeper straps which come standard with each Unisuit. These straps also worked well with the Supersuit and are quite comfortable.

b. Emergency Ascent with a Flooded Suit: Each suit was completely flooded at 15 FSW in the OSF Test Pool while using scuba. The watertight zippers were left completely open to simulate a large tear in each suit. Even though hooded suits caused the divers to become negatively buoyant, they were easily able to swim to the surface under their own power without assistance. Using the L.P. inflator to form an air pocket in the shoulder area of each suit allowed the divers to attain the desired buoyancy.

c. Inlet/Exhaust Valve Flow Capability: One possibly serious situation would be the failure of the inlet valve in the open position with the exhaust valve unable to vent the excess flow. To test this failure mode a diver in each of the suits was positioned on the bottom of the OSF Test Pool; inlet valves on each suit were then fully depressed for 15 seconds before opening the exhaust valves. Both suits were easily able to maintain depth and no indication of blowup was experienced since exhaust valves in both suits were more than adequate to handle inlet air flow.

d. Accidental Blowup: To simulate an accidental blowup, a scuba-equipped diver in each suit was placed on the bottom of the OSF Test Pool. While holding on to a padeye on the bottom, divers fully inflated their suits and assumed an upside-down, vertical position. The padeye was then released. Both divers were able to right themselves and successfully vent the suit to a

point of negative buoyancy within 10 feet of the bottom. It is important to note that a diver wearing a variable volume dry suit must use the size that correctly fits him. A small diver in a large suit loses much mobility and dexterity; air can become trapped in the folds of the suit material and thus make it extremely difficult to vent the suit adequately under emergency conditions.

7. Swimming Characteristics (Test 7)

The Unisuit and Supersuit represent two different approaches to the design of a variable volume dry suit. The Unisuit is a loose fitting suit which allows the addition of several layers of undergarments for increased thermal protection. The Supersuit is form fitting, similar to a diver's wet suit. The wearing of undergarments for additional thermal protection requires that the diver use the next larger size suit to allow room for the additional bulk. Consequently, the Unisuit is very well suited to surface supplied diving with the MK 1 Mod 0 Mask where very high levels of mobility are not required. Conversely, the Supersuit has excellent swimming characteristics and it was the unanimous consent of all test divers that for distance swims the Supersuit was the more comfortable of the two suits evaluated. However, both suits provide adequate thermal protection for either the free swimming or tethered diver without adversely affecting the diver's performance.

8. Suit Accessories Evaluation (Test 8)

All suit accessories for both the Supersuit and Unisuit were found acceptable and offered a high level of comfort, watertight integrity and ease of use.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The Poseidon Unisuit and the O'Neill Supersuit may be used safely and effectively as variable volume dry suits during applicable Navy diving operations. Any commercially available L.P. inflator may be used with the Supersuit to supply suit inflation. The Unisuit requires its own special inflation hose and connector. Both suits will function adequately as a diver's life preserver/buoyancy compensator when open circuit scuba is used.

Currently approved U.S. Navy diver's life preservers exhibit some problems in interfacing with the dry suits. In situations requiring the use of a diver's life preserver with the dry suit, several of the approved types have proven adequate.

The dry suits tested will interface adequately with all applicable UBA. Air consumption required for the dry suit L.P. inflator is minimal and poses no potential hazard when supplied directly from a scuba diver's primary air supply.

RECOMMENDATIONS

Based on the results of the aforementioned tests, it is recommended that:

1. The O'Neill Supersuit be placed on the list of equipment approved for Navy use (NAVSEAINST 9597.1);
2. Both suits may be used as variable volume (L.P. inflator) dry suits when diving with scuba, Diver's Mask MK 1 Mod 0 system with emergency back-up (come home) bottle, or MK 15 Mod 0 UBA;
3. The suits may be supplied with L.P. compressed air via any commercially available, applicable L.P. inflation mechanism;
4. The L.P. inflators may be powered from a scuba diver's first stage regulator of his primary air supply, providing a submersible pressure gauge is used;
5. The L.P. inflator may be powered from the first stage of Diver's Mask MK 1 Mod 0 back-up (come home) bottle;

(6) The subject suits may serve as a diver's life preserver/buoyancy compensator when open circuit scuba is used. However, under these conditions the L.P. inflator must be supplied from a pony bottle which is independent of the diver's primary air supply;

(7) The dry suits may be used as variable volume suits when used with the MK 15 Mod 0 UBA, providing the L.P. inflator is supplied from a pony bottle, independent of the MK 15 primary gas supply;

(8) It be recognized that these recommendations essentially introduce a new dimension in self-contained Navy diving. Inadvertent blowup is a potential hazard among divers unfamiliar with this type of equipment. Therefore, diving in this mode should be properly taught in the training commands and all diving commands should implement a comprehensive on-the-job training program to assure that divers are thoroughly familiar with the operational characteristics of this type of diving.

REFERENCES

1. NAVSEA Code OOC Task Assignment Number 46-77, dtd 12 September 1977

2. NCSL Technical Memorandum #219-77, September 1977, "A subjective Evaluation of Commercial Dry Suits," J. F. Wattenburger

3. NCSL Technical Memorandum #241-78, October 1978, "Human Engineering Evaluation of Dry Suits for Navy Use," J. F. Wattenburger and LT J. Brady